Editorial

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1 Introduction

In wireless sensor network (WSN) deployments (Bri et al., 2009; Garcia et al., 2010), wireless sensor nodes should be strategically placed to maximise the sensed area while minimising the number of nodes to be placed in the field (Pal, 2010). Moreover, wireless radio coverage distances should be taken into account to cover large areas (Lloret et al., 2009a, 2011). Wireless sensors may be located quite far from each other, allowing lower deployment costs, but it may increase the wireless sensor node power consumption due to the energy needed to reach large distances.

Although many factors may affect the position of each wireless sensor node inside the WSN, there are two main ones: the radio coverage area, which allows the sensors to communicate, and, the sensing coverage area, which gives the sensing region (Mulligan and Ammari, 2010). Both types of coverage areas could also be affected by the field where the WSN is deployed, but different factors impact in different manner to each type of coverage. The goal is to maximise the coverage percentage, while coverage holes should be minimised. Many recent publications have studied indoor radio coverage (Sendra et al., 2012) and the interference between channels when overlapping coverage exists (Sendra et al., 2011). There are also other works focused on maximising coverage taking into account the energy efficiency (Lehsaini et al., 2010). From the location perspective, some works use an energy-efficient cell partition to locate the sensors and their information (Matsumae, 2009), even predicting subcellular localisation (Thampi and Sekaran, 2005) and locating using prior information (Chen et al., 2013), others use a system based on two classes (Gui et al., 2011), and others take into account particle filter and dynamic exclusion techniques (Al-Fuqaha, 2013). But many of these studies are focused on indoor systems due to the lack of global position system (GPS), e.g., we can see a trilateration system in Garcia et al. (2007), a system that uses artificial intelligence, by means of a previous training step, in Lloret et al. (2009b) and a mixed trilateration-intelligent system in Lloret et al. (2009c). Some researchers have studied localisation algorithms in duty-cycled systems (Fan et al., 2010; Chen et al., 2011). All these research papers demonstrate that both, wireless nodes localisation/positioning and wireless nodes coverage, have experienced very much advances in the last years.

This special issue is focused on wireless sensor node location and positioning techniques, taking into account their constraints and the new advances to improve wireless coverage in WSNs. The proposed topics included, but were not limited to:

- WSN radio coverage
- WSN sensing field
- WSN deployment zones
- isotropic and sectorial sensing nodes
- positioning systems
- node location techniques
- analytical node placement systems
- 2D and 3D regions of interest in WSNs
- theoretical systems and analytical methods to maximise the radio and sensing coverage
- sensing gain and power gain systems
- sleep scheduling techniques for enhancing WSN coverage
- self-organisation strategies.

We received 98 papers in this special issue. It demonstrates that it is a hot topic in the research community. Between those papers, we have selected the best 18 papers based on the reviewers' comments and several review rounds. We give many thanks to the reviewers for their time revising the papers and providing useful comments to the authors. Moreover, we would also like to express our gratitude to the authors for their patience during the delayed review process, given by the high amount of received papers.

The remainder of this editorial is structured as follows. Section 2 shows the papers focused on localisation and positioning protocols and algorithms. Papers focused on wireless coverage methods and strategies are included in Section 3. Section 4 provides accepted papers focused on experiments in real test beds. Finally, Section 5 provides the conclusion and future trends.

2 Localisation and positioning protocols and algorithms

In this section, we present the accepted papers focused on localisation and positioning protocols and algorithms.

The paper 'A routing enhanced localisation algorithm for wireless sensor networks' takes advantage of the routing information to improve sensor localisation. They propose a localisation algorithm that integrates shortest

route discovery strategy adopts reverse sequence operation from the sink node to all other nodes. While each node set up a next hop biding table, they transform the adjacent matrix to convert the local position of the neighbouring nodes to global coordinate position. This algorithm does not take node mobility into account.

In the paper, 'Events localisation and estimation in wireless sensor networks using compressed sensing', Liu et al. use a compressive sensing method to efficiently achieve the positions. If a signal is sparse or sparse in some certain basis, then it can be sampled by a matrix obeying some certain characteristics. Thus, by considering all the nodes as source nodes with sparse signal, the authors utilise a sacristy adaptive matching pursuit (SAMP) to proposed a variable step SAMP instead of the fixed step one to avoid the overestimation problem. These schemes are more efficient and take the temporal correlation between successive source signals into account to improve the detection accuracy.

The research included in 'A robust mobile anchor-based localisation technique for wireless sensor network using smart antenna' supposes that the WSN is modelled with a mobile anchor node system. The anchor node selects a cluster of targets for localisation according to RSS measurement technique. While it also take advantage of the angle of arrival AOA. A target node estimate itself after taking only two successive beacon messages from anchor node. This scheme has low requirement of hardware while leads to a huge amount of latency.

The paper with title 'An adaptive range-free localisation protocol in wireless sensor networks' shows that most of the existing algorithms neglect the possible problems in a real wireless network context. Thus, they propose an adaptive range-free localisation protocol (ALP) based on IEEE 802.15.4 standard, which can evaluate localisation algorithms. The data payload formats and the new access method E-CSMA/CA proposed in this paper can improve the performance of non-slotted CSMA/CA. In addition, the authors suggest an adaptive approach which combines a new protocol with less than three neighbour anchors named as ALP-3 and another protocol with at least three neighbour anchors named ALP+3, this mechanism has low network overhead.

Han et al. presented 'Parameter optimisation in duty-cycled wireless sensor networks under expected network lifetime', which aims at finding the most optimal network parameters to gain the most collected data during the certain network lifetime. The authors first compare the energy consumption of WSN with two different sleep schedules: coordinated and randomised duty-cycled sleep schedule networks. Then by analysing and calculation the energy consumption, the task is transformed into a mathematic problem. The authors finally find an available way to achieve the most data collection with certain network parameters. The expected network lifetime and sleep schedule is the main innovative points of this paper.

3 Wireless coverage methods and strategies

In this section, we present the papers focused on wireless coverage methods and strategies.

Sendra et al. perform an analytical study measuring the signal strength of IEEE 802.11a/b/g/n inside a building to identify which the best location to place the sensors is. Furthermore, these results are compared for each technology with theoretical distribution channels to avoid interferences when designing WSNs. The results provide some conclusions regarding the performance of the different technologies for indoor scenarios. Finally the paper proposes a method for estimating the signal strength in indoor environments.

The paper presented by Feng et al. shows a new coverage strategy for WSNs in a three-dimensional environment. Using different coverage parameters including the cost factor, reduction parameter and perceived probability parameters, the proposed approach transforms from 3D space to the 2D plane, to determine the deployment strategy of sensor nodes. While the experimental simulation results are consistent with the previous theories achieving the coverage requirements of the WSNs, they indicate that this approach can determine the coverage with fewer nodes than previous solutions.

Habib and Marimuthu present an integrated restoration framework for communication failures in WSNs. The restoration problem is becoming critical in communications, especially in WSNs, and the proposed formulation of the restoration problem is considered as an optimisation problem to solve communication and coverage issues. To improve the lifespan of WSNs the work utilises simulated annealing as a search tool to discover the neighbourhood space of both failing sensors and base stations.

In 'Distributed clustering approach for UAV integrated wireless sensor networks', the coverage problem in unmanned aerial vehicle (UAV) integrated WSNs using the UAV as mobile sink node is presented. The analysis suggests that clustering in inaccessible locations and in large scale WSNs is an appropriate approach to increase coverage. On the basis of this analysis a distributed clustering approach is proposed to reduce the energy consumption while avoiding uncovered nodes in the network and constructing more stable and well balanced clusters.

Deng et al. study two barrier coverage problems in WSNs in 'Barrier coverage in wireless sensor networks with adjustable sensing ranges', the barrier lifetime maximisation (BLM) problem and barrier gap mending (BGM) problem. They propose several solutions for the two problems, a LP-based centralised scheme and two distributed heuristics for the BLM problem, and min-max scheme and max-lifetime scheme for the BGM problem. The results obtained in the work can be used as guidelines to maximise the lifetime in WSNs while avoiding gaps in barrier coverage.

In 'Random deployment of wireless sensor networks: a survey and approach' the authors present a survey and taxonomy of existing random node placement strategies in WSNs. They carry out an empirical study yielding a detailed analysis of intrinsic properties of random node placement in WSNs such as coverage, connectivity, fault tolerance and network lifespan. Furthermore, they propose a hybridisation of the simple diffusion model that ensures best performance. The obtained results can be used as guidelines in WSNs design using random deployment strategies.

4 Experiments in real test beds

Accepted papers which include experiments in real test beds are included in this section.

In 'A wireless sensor network deployment to detect the degeneration of cement used in construction', Sendra et al. propose a non-invasive technique for the detection of structural movement in buildings affected by the degeneration of the cement used in construction. They show the development and implementation of a WSN which is able to detect the structural movement. Wireless nodes are able to sense the temperature, humidity, micro-vibrations and structural movements. Moreover, it studies and discusses the most appropriate locations to place the multisensor nodes and the physical sensors in a simple structure to take the most suitable measurements and ensure the reliability of the data. The paper explains the hardware deployed and the energy consumption of the multisensor nodes and shows the sensor node web interface.

Lin et al. propose a fingerprinting localisation scheme in 'Fingerprinting Localisation with Cruciate Directional Antennas for Wireless Sensor Networks'. WSNs that can do localisation by a sole anchor node equipped with four directional antennas arranged in a cross pattern so that an antenna's orientation is perpendicular to those of adjacent ones. Authors experimentally analysed the influence of measuring interval of fingerprints on the localisation error.

The paper 'Analysis of challenges in the application of deterministic wireless channel modelling in the implementation of WLAN-based indoor location system in large complex scenarios' presents the design and analysis of WLAN-based location systems. The wireless channel has been characterised by means of in-house implemented 3D ray launching code. The technique has been tested in two different scenarios. The results could help to determine an optimised WiFi-based location system for providing efficient positioning and communication services in complex indoor scenarios.

In 'Reality-proof activity scheduling for energy-efficient wireless sensor networks', Beaudaux et al. improved several activity scheduling mechanisms for WSNs by introducing a new activity state called 'Sensing Only' to maximise the energy gains. On the basis of routing layer information, the proposed technique determines the nodes that can be switched Sensing-Only. Authors argue that the introduction of Sensing-Only mechanism reduces by a third to a half the number of active nodes in the network.

Chaudet et al. propose and evaluate a family of algorithms to enhance indoor positioning of wireless devices. Authors compared their proposed techniques with three different testbed algorithms. The landmarks selection is first performed by maximising the likelihood in the resulting subset of landmarks. A heuristic approach that selects excluded landmarks based on a threshold on the bias has been evaluated.

In 'Performance assessment of a new intra-mobility solution for healthcare wireless sensor networks', Caldeira et al. study the performance of a new handover mechanism to support intra-mobility of sensor nodes for healthcare WSNs, called Hand4MAC. The evaluation is performed through a laboratory testbeds and the Hand4MAC was compared with the most used solutions of handover mechanisms. The results show that Hand4MAC is more efficient and it ensures almost continuous connection to the sensor nodes.

5 Conclusion and future trends

In this editorial, we present the recent advances on Localisation, Positioning and Coverage in WSNs. After having received a huge amount of submissions, we have selected the best 18 papers based on the reviewers' comments. These papers have been classified in three main sections: Localisation and positioning protocols and algorithms, wireless coverage methods and strategies, and experiments in real test beds. We have received a considerable amount of papers that include real tests, which demonstrate that the state of the art of these topics is now more focused on the experimental part than on the models or analytical proposals.

The future trends in this area are focused on achieving lower costs in the systems deployment, while providing higher accuracy in indoor environments.

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